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A HIGH SHRINKAGE SIDE BY SIDE TYPE COMPOSITE FILAMENT AND A METHOD FOR MANUFACTURING THE SAME

TECHNICAL FIELD

The present invention relates to a side-by-side type composite (conjugate) filament which has a high elastic property (shrinkage) even in a filament state, and to a method for manufacturing the same.

More particularly, the present invention relates to a side-by-side type composite filament, which can omit a false-twisting process and can attain a fine denier filament since it has a superior crimp even in a filament state where no false-twisting treatment has been carried out, and to a method for manufacturing the same.

BACKGROUND ART

Synthetic fibers have reached the level not inferior to natural fibers in some properties owing to repeated technical development in spite of their short history. But, the crimp property is a property which is not easy for synthetic fibers to exhibit and is being considered as an intrinsic property of natural fibers such as wool.

As prior art methods providing synthetic fibers with crimp

properties are (i) a method for manufacturing a different shrinkage composite false twisted yarn by doubling, false-twisting and heat-setting two kinds of synthetic fibers (yarns) having a big difference in shrinkage properties, (ii) a method for mixing a polyurethane fiber with an excellent crimp property in a longitudinal direction and other synthetic fiber upon manufacturing woven or knitted fabrics, and (iii) a method for manufacturing a composite fiber by conjugated-spinning two kinds of polymers.

Of these methods, the method for manufacturing a different shrinkage composite false twisted yarn is a method that provides a potential shrinkage difference by mixing, false-twisting and heat-setting two kinds of yarns having a big difference in shrinkage properties. That is to say, this method makes the best of a difference between a strain in false twist areas and a residual strain after untwisting, in which a core yarn is deformed relatively larger than a effect yarn to be mixed and crosslinked with the effect yarn.

The different shrinkage composite false twisted yarn exhibits a good elastic property due to a difference in elongation between core yarns and effect yarns. But, the above method was disadvantageous in that, since the appearance of crimps is uneven and the binding force of core yarns and effect yarns is relatively

small because it is dependent upon air texturing and the like, one component yarn is released or removed by a physical force applied during a after-process or the crimping property is decreased.

In addition, the above method for manufacturing a different shrinkage composite false twisted yarn was problematic in that it is difficult to provide a fine fineness because two or more kinds of yarns have to be mixed, and the process becomes complicated and the manufacturing cost is increased because the two or more kinds of yarns pre-produced have to be rewound and combined again.

On the other hand, the method for mixing a polyurethane fiber and other synthetic fiber upon manufacturing woven or knitted fabrics was disadvantageous in that it is difficult to process because the synthetic fiber is different from the polyurethane fiber in physical and chemical properties. For instance, the polyester fiber is dyed using a disperse dye while a polyurethane fiber has to be dyed with an acid dye or a metal-containing dye.

Therefore, in a case that the polyester fiber and the polyurethane fiber are mixed upon manufacturing woven or knitted fabrics, there are many problems that, for example, it is necessary to use a chlorobenzene or methyl naphthalene carrier for dyeing, and the final product is weak to a chlorine bleaching

agent and easily hydrolysable by NaOH.

Meanwhile, a synthetic fiber manufactured by a polybutylene terephthalate (PBT) resin has a problem that they have to undergo a false twisting process for improving elastic property because of their lack of shrinkage in a filament state.

Accordingly, it is an object of the present invention to provide a side-by-side type composite filament which has a superior crimp property even in a filament state and thus requires no false-twisting process.

DISCLOSURE OF THE INVENTION

The present invention provides a side-by-side type composite filament which has a excellent shrinkage even in a filament state which is not passed false-twisting process. Additionally, the present invention provides a method for manufacturing a high elastic side-by-side type composite filament which has a simple process and can attain a fine denier filament since a false-twisting process can be omitted.

To achieve the above objects, there is provided a high crimp (shrinkage) side-by-side type composite filament according to the present invention, wherein two kinds of thermoplastic polymers are arranged in side by side type and a boiling water shrinkage (Sr_2) measured by the method (initial load = notified denier ×

1/10g, static load = notified denier × 20/10g) of clause 5.10 of JIS L 1090 is 20 to 75% of a boiling water shrinkage (Sr_1) measured by the method (initial load = notified denier × 1/30g, static load = notified denier × 40/30g) of clause 7.15 of JIS L 1013.

Additionally, there is provided a method for manufacturing a high shrinkage side-by-side type composite filament according to the present invention consisting two kinds of thermoplastic polymers which are arranged in side by side type, wherein two kinds of thermoplastic polymers having a number average molecular weight difference ($\triangle$Mn) of 5,000 to 15,000 are used upon spinning and the composite filament is drawn and heat-treated so as to satisfy the following physical properties:

· Temperature area exhibiting 95% of maximum thermal stress (Tmax, 95%) : 120 to 230°C

· Range of maximum thermal stress per denier : 0.1 to 0.4g/denier

Hereinafter, the present invention will be described in detail.

Firstly, in the present invention, a side-by-side type composite filament is manufactured by conjugated-spinning two kinds of thermoplastic polymers in side by side type and then drawing and heat-treating the composite filament spun by a continuous or discontinuous process.

Specifically, in the present invention, a side-by-side type composite filament can be manufactured by a spin-direct draw method which carries out spinning, drawing and heat-treating in one process as shown in Fig. 1, or a side-by-side type composite filament can be manufactured by conjugated-spinning two kinds of thermoplastic polymers in side by side type to prepare an undrawn or half-drawn composite filament and then drawing and heat-treating the undrawn or half-drawn composite filament by a discontinuous process as shown in Fig. 2.

The present invention is characterized in that two kinds of thermoplastic polymers having a number average molecular weight difference ($\triangle$Mn) of 5,000 to 15,000 are used upon conjugated spinning. The thermoplastic polymers include polyethylene terephthalate, etc.

The polyethylene terephthalate is produced by an ester interchange between ethylene glycol and terephthalic acid dimethyl, or by polymerization between ethylene glycol and terephthalic acid. At this time, if the polymerization time is adjusted, a number (n) of chains of polyethylene terephthalte can be adjusted, and a polyethylene terephthalte with desired molecular weight can be obtained.

The number average molecular weight is a value measured by Gel Permeation Chromatograpy (GPC).

If the number average molecular weight difference ($\triangle$Mn) between the polymers is smaller than 5,000, the difference in degree of orientation between the polymers is insufficient and thus the shrinkage ratio of the final product becomes lower. If greater than 15,000, the shrinkage ratio is superior but a serious yarn swelling phenomenon occurs upon spinning due to an excessive difference in number average molecular weight and the yarn strength becomes lower to thereby make it difficult to set a stable spinning condition.

The side-by-side type composite filament has such a shape that two kinds of thermoplastic polymers are bonded each other to form an interface dividing the filament into halves and its cross section is a circular type, a rectangular type, a cocoon type, etc.

The shape of the cross section is freely changeable according to a cross section shape of a spinneret hole and a bonding method of polymers, and the interface has a linear shape or a bow-like curved shape according to a difference in melt viscosity between polymers. Generally, a polymer having a low melt viscosity surrounds a polymer having a high viscosity to form an interface of a bow-like curved shape.

Meanwhile, the present invention is characterized in that the finally manufactured composite filament is drawn and

heat-treated so as to satisfy the following physical properties:

· Temperature area exhibiting 95% of maximum thermal stress (Tmax, 95%) : 120 to 230°C

· Range of maximum thermal stress per denier : 0.1 to 0.4g/denier

Preferably, the composite filament is drawn and heat-treated so that the temperature distribution range of maximum thermal stress of the finally manufactured composite filament is 140 to 200°C. If the temperature distribution range of maximum thermal stress is deviated from the above range, the processibility may be deteriorated or the quality of woven or knitted fabrics may be degraded.

Further, if the range of maximum thermal stress per denier is smaller than 0.1g/denier, the appearance of crimps is degraded, or if greater than 0.4g/denier, it becomes hard to control the shrinkage.

Further, if the temperature distribution range of maximum thermal stress is smaller than 140°C or the temperature area (Tmax, 95%) exhibiting 95% of maximum thermal stress is smaller than 120°C, the shrinkage becomes too large and thus the appearance of crimps is degraded. On the contrary, if the temperature distribution range of maximum thermal stress is greater than 200°C or the temperature area (Tmax, 95%) exhibiting 95% of maximum thermal

stress is greater than 230°C, the drawing stability is degraded.

In order for the drawn and heat-treated composite filament to satisfy the physical properties, a temperature of heat treatment in a second Godet roller (6) is adjusted in the spin-direct draw method of Fig. 1, and a temperature of heat treatment in a hot plate (12) is adjusted in the method of drawing and heat treatment by a discontinuous process as shown in Fig. 2.

The side-by-side type composite filament manufactured by the above-mentioned method according to the present invention has two kinds of polymers arranged side by side type and tends to have a different boiling water shrinkage from that of a typical composite fiber filament.

Generally, a synthetic fiber filament and a textured synthetic fiber yarn (false-twisted yarn) have a different condition for measuring a boiling water shrinkage from each other due to their difference in crimp property. Specifically, since the synthetic fiber filament has almost no crimp, the possibility of an error according to a change of the condition of measuring a boiling water shrinkage is relatively low. On the contrary, since the textured synthetic fiber yarn (false-twisted yarn) has relatively many crimps, the possibility of an error according to a change of the measuring condition is relatively high.

The boiling water shrinkage of the synthetic fiber filament is mostly measured by the method (initial load = notified denier × 1/30g, static load = notified denier × 40/30g) of clause 7.15 of JIS L 1013 while the boiling water shrinkage of the textured synthetic fiber yarn (false-twisted yarn) is mostly measured by the method (initial load = notified denier × 1/10g, static load = notified denier × 20/10g) of clause 5.10 of JIS L 1090.

In the side -by-side type composite filament of this invention, the boiling water shrinkage (Sr_2) measured by the method of clause 5.10 of JIS L 1090 is 20 to 75% of the boiling water shrinkage (Sr_1) measured by the method of clause 7.15 of JIS L 1013.

In other words, in case of the side -by-side type composite filament of this invention, the boiling water shrinkage (Sr_2) measured under the condition of measuring the boiling water shrinkage of a textured synthetic fiber yarn (false-twisted yarn) is 20 to 75% of the boiling water shrinkage (Sr_1) measured under the condition of measuring the boiling water shrinkage of a synthetic fiber filament.

On the contrary, in case of a general synthetic fiber filament, the boiling water shrinkage (Sr_2) measured under the condition of measuring the boiling water shrinkage of a textured synthetic fiber yarn (false-twisted yarn) is 90 to 99% of the

boiling water shrinkage (Sr_1) measured under the condition of measuring the boiling water shrinkage of a synthetic fiber filament, which is almost not different from a boiling water shrinkage measured regardless of a measuring method.

As described above, the side-by-side type composite filament of this invention is similar to a textured yarn (false-twisted yarn) in the boiling water shrinkage behavior in spite of its filament form, and is much superior to the textured yarn in the crimp performance.

In the present invention, various physical properties of the composite filament and of a woven or knitted fabric are evaluated as below.

· Boiling Water Shrinkage (Sr_1 and Sr_2) and Crimp Recovery Rate (CR)

The boiling water shrinkage (Sr_1) was measured by the method of clause 7.15 of JIS L 1013 and the boiling water shrinkage (Sr_2) was measured by the method of clause 5.10 of JIS L 1090. Specifically, a hank was prepared by winding a composite filament around a creel 10 or 20 times (20 times in the method of clause 7.15 of JIS L 1013 and 10 times in the method of clause 5.10 of JIS L 1090). An initial load and a static load were applied to the prepared hank to measure the length (L_0). In the method of clause 7.15 of JIS L 1013, the initial load equals to notified

denier × 1/30g and the static load equals to notified denier × 40/30g). In the method of clause 5.10 of JIS L 1090, the initial load equals to notified denier × 1/10g and the static load equals to notified denier × 20/10g. The hank was heat-treated for 30 minutes in a hot water of 100°C ± 2°C, taken out, dewatered with a moist absorbent paper, and left indoors. Then, the initial load and the static load corresponding to each of the methods were applied again to the hank to measure the length (L_1). Continuously, the hank with initial load and static load was left in the water of 20°C ± 2°C and then the sample length (L_2) was measured. The static load was removed again and left and then the sample length (L_3) was measured. The measured values are substituted into the following formula to calculate the boiling water shrinkage and the crimp recovery rate.

$$\text{Boiling water shrinkage } (Sr_1 \text{ and } Sr_2) = \frac{L_0 - L_1}{L_0} \times 100(\%)$$

$$\text{Crimp recovery rate (CR)} = \frac{L_2 - L_3}{L_2} \times 100(\%)$$

· Elastic property of Fabric

It was evaluated by an organoleptic test using a panel composed of 30 people. If 25 or more out of 30 people judges the shrinkage of a fabric excellent, it is represented as ◎. If 20 to 24 people judge it excellent, it is represented as ○. If 10

to 19 people judge it excellent, it is represented as △. If 9 or less people judges it excellent, it is represented as ×.

·Temperature (Tmax) Exhibiting Maximum Thermal Stress and Maximum Thermal Stress Per Denier (g/denier)

They were measured by a Thermal Stress Tester of Kanebo Engineering Co. Ltd. Specifically, a loop-shaped sample having a 10cm length was suspended on upper and lower hooks and then a predetermined tension [notified denier of composite filament ×2/30g] was applied to the sample. In this state, the temperature was raised at a predetermined speed (300°C/120seconds). A stress change corresponding to a temperature change was drawn on a chart as shown in Fig. 3 and then a temperature area (Tmax, 95%) exhibiting more than 95% of maximum the thermal stress was obtained with the maximum thermal stress as a center. The maximum thermal stress per yarn denier was calculated by obtaining maximum thermal stress on the chart and then substituting it into the following formula.

$$\text{Maximum Thermal Stress Per Denier} = \frac{\text{Maximum Thermal Stress}}{\text{Notified denier of Composite Filamment} \times 2}$$

·Number Average Molecular Weight (Mn) and Weight Average Molecular Weight (Mw)

They were measured using the gel permeation chromatograph (GPC) method by the following formula:

$$Mn = \frac{\sum_{i=1}^{n} Hi}{\sum_{i=1}^{n} Hi/Mi}$$

$$Mw = \frac{\sum_{i=1}^{n} Hi \times Mi}{\sum_{i=1}^{n} Hi}$$

Hi: length of signal of detector on baseline of retention volume (Vi)

Mi: molecular weight of polymer fraction in retention volume (Vi)

N: number of data

Wherein the retention volume (Vi) is the volume of solvent consumed during the retention time of sample component molecules in columns.

The retention time is the time taken until the sample component molecules enter the columns and melt out.

Since the results measured by the above method are relative values, a standard material is used in order to compensate these values. As the standard material, mainly used is polystyrene, of which the molecular weight and the breadth of the molecular weight distribution are already known. Other kinds of standard materials also may be used on a proper basis.

The breadth of the molecular weight distribution is the width of the peak value of the molecular weight distribution and

represents the dispersity (Mw/Mn) of a target polymer material.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of a process for manufacturing a high crimp side-by-side type composite filament according to the present invention by a spin-direct draw method;

Fig. 2 is schematic view of a process for manufacturing a high crimp side-by-side type composite filament according to the present invention by drawing and heat treatment an undrawn yarn or a half-drawn yarn;

Fig. 3 is a thermal stress curve of the composite filament of the present invention charted in a thermal stress tester;

Fig. 4 is a micrograph showing the cross sectional state of the side-by-side type composite filament according to the present invention;

Fig. 5 is a micrograph showing the state of the side-by-side type composite filament before heat treatment according to the present invention; and

Fig. 6 is a micrograph showing the state of the side-by-side type composite filament after a hot water treatment (100°C) according to the present invention.

* Explanation of Reference Numerals for Main Parts in the Drawings

1,2: extruder 3: spinning block 4: quenching chamber 5: first

Godet roller

6: second Godet roller 7: conjugate filament 8: draw winder

10: undrawn yarn or half-drawn yarn drum 11: hot roller

12: hot plate 13: draw roller 14: conjugate filament

Tg: initial shrinkage start temperature

Tmax: temperature exhibiting maximum thermal stress

$T\alpha$: lower limit value of temperature area exhibiting 95% of maximum thermal stress

$T\beta$: upper limit value of temperature area exhibiting 95% of maximum thermal stress

BEST MODE FOR CARRYING OUT THE INVENTION

The present invention is now understood more concretely by comparison between examples of the present invention and comparative examples. However, the present invention is not limited to such examples.

Example 1

A polyethylene terephthalate with a number average molecular weight (Mn) of 15,000 and a polyethylene terephthalate with a number average molecular weight (Mn) of 25,000 are conjugated-spun in side by side type at a speed of 3,000m/min at a temperature of 285°C. The resulting material is drawn and heat-treated at a draw speed of 650m/min and at a drawn ratio of

1.68 in a drawing and heat treatment process as shown in Fig. 2, to prepare a side-by-side type conjugate (composite) filament having 100 deniers/24 filaments. The drawing and heat-treatment temperature (hot plate temperature) is set to 132°C so that the composite filament can satisfy the following physical properties.

Maximum thermal stress per denier: 0.21g/denier

Temperature exhibiting maximum thermal stress (Tmax): 155°C

Temperature area exhibiting 95% of maximum thermal stress (Tmax, 95%): 122 to 228°C

Next, a five-harness satin with a warp density of 190 yarns/inch and a weft density of 98 yarns/inch is woven in a rapier loom using the conjugate filament as a warp and a weft, then scoured/contracted, then dyed in a rapid dyeing machine of 125°C, and then after-processed under a typical postprocessing condition, thereby making a fabric. The results of measuring various physical properties of the prepared side-by-side type conjugate filament and of the fabric made thereof are as shown in Table 1.

Example 2

A polyethylene terephthalate with a number average molecular weight (Mn) of 12,000 and a polyethylene terephthalate with a number average molecular weight (Mn) of 25,000 are conjugated-spun in side by side type at a speed of 3,000m/min at a temperature of 285°C. The resulting material is drawn and

heat-treated at a draw speed of 650m/min and at a drawn ratio of 1.68 in a drawing and heat treatment process as shown in Fig. 2, to prepare a side-by-side type conjugate filament having 100 deniers/24 filaments. The drawing and heat-treatment temperature (hot plate temperature) is set to 140°C so that the composite filament can satisfy the following physical properties.

Maximum thermal stress per denier: 0.31g/denier

Temperature exhibiting maximum thermal stress (Tmax): 165°C

Temperature area exhibiting 95% of maximum thermal stress (Tmax, 95%): 122 to 228°C

Next, a five-harness satin with a warp density of 190 yarns/inch and a weft density of 98 yarns/inch is woven in a rapier loom using the conjugate filament as a warp and a weft, then scoured/contracted, then dyed in a rapid dyeing machine of 125°C, and then after-processed under a typical postprocessing condition, thereby making a fabric. The results of measuring various physical properties of the prepared side-by-side type conjugate filament and of the fabric made thereof are as shown in Table 1.

Example 3

A polyethylene terephthalate with a number average molecular weight (Mn) of 16,000 and a polyethylene terephthalate with a number average molecular weight (Mn) of 28,000 are conjugated-spun in side by side type at a temperature of 290°C.

The resulting material is drawn and heat-treated in a continuous drawing and baking process as shown in Fig. 1, to prepare a side-by-side type conjugate filament having 100 deniers/24 filaments. The temperature of a first Godet roller is set to 82°C and the speed thereof is set to 1,800m/min. The speed of a second Godet roller is set to 4,815m/min, the speed of a take-up roller is set to 4,800m/min, and the temperature of the second Godet roller is set to 163°C, so that the conjugate filament can satisfy the following physical properties.

Maximum thermal stress per denier: 0.16g/denier

Temperature exhibiting maximum thermal stress (Tmax): 175°C

Temperature area exhibiting 95% of maximum thermal stress (Tmax, 95%): 122 to 228°C

Next, a five-harness satin with a warp density of 190 yarns/inch and a weft density of 98 yarns/inch is woven in a rapier loom using the conjugate filament as a warp and a weft, then scoured/contracted, then dyed in a rapid dyeing machine of 125°C, and then after-processed under a typical postprocessing condition, thereby making a fabric. The results of measuring various physical properties of the prepared side-by-side type conjugate filament and of the fabric made thereof are as shown in Table 1.

Comparative Example 1

A polyethylene terephthalate with a number average

molecular weight (Mn) of 21,000 and a polyethylene terephthalate with a number average molecular weight (Mn) of 25,000 are conjugated-spun in side by side type at a speed of 3,000m/min at a temperature of 285°C. The resulting material is drawn and heat-treated at a draw speed of 650m/min and at a drawn ratio of 1.68 in a drawing and heat treatment process as shown in Fig. 2, to prepare a side-by-side type conjugate filament having 100 deniers/24 filaments. The drawing and heat-treatment temperature (hot plate temperature) is set to 118°C so that the composite filament can satisfy the following physical properties.

Maximum thermal stress per denier: 0.21g/denier

Temperature exhibiting maximum thermal stress (Tmax): 135°C

Temperature area exhibiting 95% of maximum thermal stress (Tmax, 95%): 122 to 228°C

Next, a five-harness satin with a warp density of 190 yarns/inch and a weft density of 98 yarns/inch is woven in a rapier loom using the composite filament as a warp and a weft, then scoured/contracted, then dyed in a rapid dyeing machine of 125°C, and then after-processed under a typical postprocessing condition, thereby making a fabric. The results of measuring various physical properties of the prepared side-by-side type conjugate filament and of the fabric made thereof are as shown in Table 1.

Comparative Example 2

A polyethylene terephthalate with a number average molecular weight (Mn) of 20,000 and a polyethylene terephthalate with a number average molecular weight (Mn) of 25,000 are conjugated-spun in side by side type at a speed of 3,000m/min at a temperature of 285°C. The resulting material is drawn and heat-treated at a draw speed of 650m/min and at a drawn ratio of 1.68 in a drawing and heat treatment process as shown in Fig. 2, to prepare a side-by-side type conjugate filament having 100 deniers/24 filaments. The drawing and heat-treating temperature (hot plate temperature) is set to 115°C so that the conjugate filament can satisfy the following physical properties.

Maximum thermal stress per denier: 0.18g/denier

Temperature exhibiting maximum thermal stress (Tmax): 130°C

Temperature area exhibiting 95% of maximum thermal stress (Tmax, 95%): 122 to 235°C

Next, a five-harness satin with a warp density of 190 yarns/inch and a weft density of 98 yarns/inch is woven in a rapier loom using the composite filament as a warp and a weft, then scoured/contracted, then dyed in a rapid dyeing machine of 125°C, and then after-processed under a typical postprocessing condition, thereby making a fabric. The results of measuring various physical properties of the prepared side-by-side type composite filament

and of the fabric made thereof are as shown in Table 1.

Comparative Example 3

A polyethylene terephthalate with a number average molecular weight (Mn) of 25,000 and a polyethylene terephthalate with a number average molecular weight (Mn) of 25,000 are conjugated-spun in side by side type at a speed of 3,000m/min at a temperature of 285°C. The resulting material is drawn and heat-treated at a draw speed of 650m/min and at a drawn ratio of 1.68 in a drawing and heat treatment process as shown in Fig. 2, to prepare a side-by-side type conjugate filament having 100 deniers/24 filaments. The temperature of a hot roll is set to 85°C and the drawing and heat-treatment temperature (hot plate temperature) is set to 130°C so that the conjugate filament can satisfy the following physical properties.

Maximum thermal stress per denier: 0.18g/denier

Temperature exhibiting maximum thermal stress (Tmax): 155°C

Temperature area exhibiting 95% of maximum thermal stress (Tmax, 95%): 122 to 235°C

Next, a five-harness satin with a warp density of 190 yarns/inch and a weft density of 98 yarns/inch is woven in a repia loom using the composite filament as a warp and a weft, then scoured/contracted, then dyed in a rapid dyeing machine of 125°C, and then after-processed under a typical postprocessing condition,

thereby making a fabric. The results of measuring various physical properties of the prepared side-by-side type conjugate filament and of the fabric made thereof are as shown in Table 1.

[Table 1]

Results of evaluating physical properties of yarn and of fabric

Classification	Physical Properties of Yarn				shrinkage of Fabric
	Sr_1 (%)	Sr_2 (%)	$(Sr_2/Sr_1)\times100$ (%)	CR (%)	
Example 1	15.40	6.89	44.7	37.7	◎
Example 2	10.80	7.04	65.2	39.9	◎
Example 3	5.70	3.48	61.1	35.8	◎
Comparative Example 1	8.90	8.10	91.0	12.7	×
Comparative Example 2	7.17	5.80	80.1	26.3	△
Comparative Example 3	7.68	7.80	98.1	2.30	×

In the above table, Sr_1 is a boiling water shrinkage of the composite filament measured by the method of clause 7.15 of JIS L 1013, and Sr_2 is a boiling water shrinkage of the conjugate filament measured by the method of clause 5.10 of JIS L 1090.

INDUSTRIAL APPLICABILITY

The side-by-side type conjugate filament of this invention

is superior in crimp property, exhibits the same properties as natural fibers and is easy to carry out a dyeing process. Further, the present invention reduces the manufacturing cost due to a simple manufacturing process and enables the composite filament to have a fine denier.